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METHOD FOR DRY POWDER MAGNETIC PARTICLE TESTING

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METHOD FOR DRY POWDER MAGNETIC PARTICLE TESTING

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METHOD FOR DRY POWDER MAGNETIC PARTICLE TESTING

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 April 1983, after the draft finalized by the Non-Destructive Testing Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Magnetic particle flaw detection is generally used to locate cracks, discontinuities, non-metallic inclusions and segregation at or just below the surface in ferromagnetic material. Dry powder magnetic particle is used for inspection of larger parts by means of movable equipment whereas the wet method employing stationery equipment is usually more convenient and effective for inspection of smaller parts, such as automotive or aircraft parts.

0.3 This standard should be used in conjunction with IS : 3703-1980*.

1. SCOPE

1.1 This standard prescribes the recommended procedure for detection of cracks and other linear indications by the dry powder magnetic particle testing. The method is applicable only to ferromagnetic material and in case of welds where the weld metal is also ferromagnetic.

1.2 This standard does not lay down any requirements for the acceptance or rejection of materials and components on which flaws have been revealed. This shall be subject to mutual agreement between the contracting parties. This agreement may provide details with regard to:

a) area to be inspected,
b) the technique to be used,
c) the type of discontinuities to be accepted, and
d) reworking and subsequent retesting which may be permissible.

---

*Code of practice for magnetic particle flaw detection (*first revision*).

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 3415-1980* shall apply.

3. PRINCIPLE OF THE METHOD AND APPLICABILITY

3.1 Principle — This method of flaw detection consists of magnetizing the area to be examined to near saturation and applying dry magnetic particle to the surface. The particle will be retained on the surface at cracks and other linear discontinuities due to leakage in the magnetic field. The patterns are characteristic of the type of defect present.

3.2 Applicability — The dry powder method is more sensitive than the wet method for detection of sub-surface discontinuities but it is comparatively less sensitive in detecting fine surface discontinuities. Dry powder method is convenient to use in conjuction with portable equipment for the inspection of large areas or for field inspection. It is therefore often used for the inspection of large parts such as large castings, forgings or weldments.

4. SURFACE CONDITION

4.1 The surface to be inspected shall be clean, dry and free from rust, oil, scale, excessive slag and other extraneous matter which may interfere with efficient inspection. As-cast or as-welded surfaces are generally satisfactory if clean. However rough surfaces such as very rough weld bead make the interpretation difficult due to mechanical trapping of the magnetic powder thereby producing false indications. In such cases surface preparation by wire brushing, sand blasting, grinding, machining or other suitable methods is necessary. Thin paint does not interfere with the formation of indications, but must be removed at points where electrical contact is made.

4.2 For improvement in contrast a quick drying non-magnetic paint may be applied over the area to be inspected.

5. INSPECTION MEDIUM

5.1 Magnetic particles used for detection of defects shall be in the dry state.

5.2 The dry powder used shall be of high permeability and low retentivity and of such size and shape that will readily produce magnetic particle indicators. It should be of a colour that will provide adequate contrast with the background of the surface being inspected. The dry powder shall conform to IS : 6410-1971†.

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†Specification for magnetic flaw detection inks and powders.

*Glossary of terms used in magnetic particle flaw detection (*first revision*)

6. MAGNETIZATION

6.0 The procedure described here provides for local circular magnetization by the use of prod-type contacts. This technique will provide satisfactory inspection of most parts intended for general industrial use where the dry powder method is applicable. There are many applications, however, where the prod method is either not satisfactory or not the most practical method. Other dry powder methods are described in Appendix A. These methods may be considered and used when specified or specifically agreed upon between the contracting parties.

6.1 Magnetizing Technique

6.1.1 Local circular magnetization is achieved by the use of portable prod-type electrical contacts pressed against the surface in the area to be examined (*see* Fig. 1).

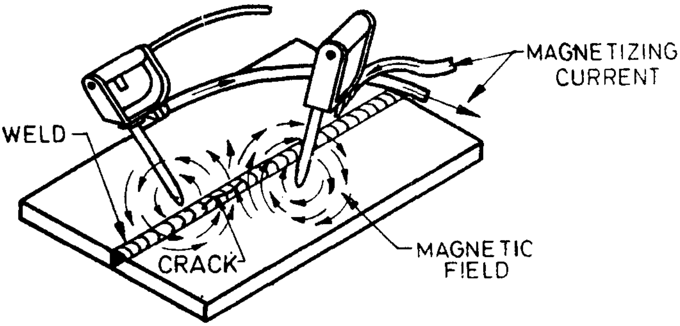

FIG. 1 CIRCULAR MAGNETIZATION WITH PROD-TYPE CONTACTS

6.1.2 The prod spacing is usually kept between 150 to 200 mm. Shorter spacing of prods may be used when the geometry of the part or its dimensions does not permit the above spacing. Prod spacing of less than 75 mm is not recommended, as it will result in banding of the particles around the prods.

6.1.3 Care should be taken to prevent local over-heating, arcing or burning of the surface being inspected. Special precautions should be taken when testing high carbon or alloy steels since hard spots or cracks could be produced by arcing. The magnetizing current shall not be turned on until after the prods have been properly positioned in contact with the surface. The prods shall be removed from the surface only after switching off the magnetizing current. This can be achieved by having a remote control switch built into the prod handles.

6.1.4 Alternating, direct or half wave rectified magnetizing current shall be used. The minimum and maximum current for various prod spacing shall be as given below:

Prod Spacing	*Magnetizing Current, A*	
mm	Section Thickness Under 20 mm	Section Thickness 20 mm and Over
50 to 100	200-300	300-400
Over 100 and up to 150	300-400	400-600
Over 150 and up to 200	400-600	600-800

6.1.5 Suitable instruments shall be used to measure the magnetizing current. This is important specifically when very long cables are used.

6.1.6 In some cases, it may be difficult to avoid arcing when testing high carbon or alloy steels by the technique of prod magnetization. In such cases, a direct current electromagnet or a permanent magnet yoke may be used, if it has got a lifting power of 20 kg with a pole spacing of 75 to 150 mm.

6.2 Direction of Magnetization—Since proper indications are obtained when the direction of magnetic field is perpendicular to the discontinuities, at least two separate examinations shall be carried out in each area. The prods shall be placed such that the magnetic field during one examination is approximately perpendicular to that during the other

6.3 Examination shall be done by the continuous method, that is the magnetization must remain on while the dry powder is applied and when excess powder is removed.

7. APPLICATION OF INSPECTION MEDIUM

7.1 The dry powder shall be applied while the magnetizing current is on, by lightly dusting dry powder over the job. An applicator may be used for rapid and uniform application of dry powder. Any excess powder may be removed with a gentle air stream. The air stream should not distrub or remove lightly held particle patterns. In order to recognise the broad, fuzzy lightly held particle patterns produced by sub-surface discontinuities, it is essential to observe carefully the formation of indications, while the particles are being removed. Proper lighting will facilitate the observation of these patterns. The temperature of the dry particles and of the surface of the part shall not exceed 315°C.

8. INSPECTION

8.1 Discontinuities are indicated by retention of magnetic particles.

8.2 A low powered magnifier is a desirable inspection aid, particularly when very small flaws are inspected.

8.3 Defects found on inspection and requiring repair or investigation shall be marked clearly using grease pencil, coloured crayon or paint.

8.4 A permanent record may be made with the help of photographs or transfers. Transfer of any indication shall be made by carefully presenting transparent pressure sensitive tape or suitable adhesive tape over the indication. The tape is then removed with the indication adhering to it. This may be placed on a piece of white paper or directly on a sketch or report to form a permanent record.

9. ASSESSMENT OF DEFECTS

9.1 If the indication is caused by the presence of surface discontinuities, the particles are held tightly to the surface by a relatively strong magnetic field. The accumulation of particles will be sharp and well defined. But if the indication is caused by sub-surface discontinuity, the particles are held in a broad, fuzzy accumulation.

9.2 Relevant indications are those which result from material discontinuities.

9.3 Non-relevant indications are caused by distortion of magnetic field resulting from magnetic writing, hard and soft spots, boundaries of heat affected zones, abrupt change of section, etc. Care shall be taken to identify and eliminate them.

9.4 Any indication suggested to be non-relevant is to be considered relevant till it is proved otherwise.

9.5 Board areas of particle accummulation which could mask indications of discontinuities are unacceptable and these areas shall be cleaned and retested.

9.6 Linear indications are those in which the length is more than three times the width.

9.7 Rounded indications are those which are circular or elliptical with the length less than three times the width.

10. DEMAGNETIZATION

10.1 Demagnetization is unnecessary unless the residual field interferes with subsequent machining, arc welding operations, or with structures such as aircraft, where sensitive electrical instruments may be affected.

11. RECORD OF TEST DATA

11.1 The following data should be recorded at the time of each testing for further reference:

a) Material,

b) Method used, dry or wet,

c) Type of magnetization,

d) Type of current,

e) Amount of current, and

f) Nature of defects.

APPENDIX A

(*Clause* 6.0)

ADDITIONAL PROCEDURES FOR DRY POWDER TESTING

A-1. This appendix describes additional procedures for magnetic particle inspection by the dry powder method which in some cases may be more practical or may produce better results. These procedures shall be used if specified or specifically agreed upon between the contracting parties. Such a specification or agreement must include specific details on the magnetizing technique, direction or directions of magnetization, type and amount of magnetizing current, sequence of operations as well as acceptance standards.

A-2. MAGNETIZATION TECHNIQUES

A2.1 Overall Magneztization—In this method the part as a whole is magnetized and generally provides a rapid means of inspection. This method can be used for parts of suitable shape and size, in which magnetic fields may be set up with proper directions and intensity. If overall magnetization is used, two separate inspections shall be carried out with the fields at approximately right angles to each other. Overall magnetization can be achieved in the following three ways.

A-2.1.1 *Circular Magnetization (Direct Method)* — In this method the part, as a whole is subjected to circular magnetization by passing the current directly through the part itself (Fig. 2). Sufficient contact area shall be provided to pass the required amperage without overheating or burning the part. The magnetizing current required shall be decided, depending upon the type of material and the nature of defects.

The current requirements depend on the diameter or the maximum dimensions of the part at right angles to the current flow and not upon the cross-sectional area of the part. In general, about 100 to 400 amperes for every 25 mm of diameter shall be used. This method will provide best indications of discontinuities which are essentially parallel to the axis of current flow (longitudinal or radial direction) but will not produce good indications of discontinuities on the inside of a hollow part.

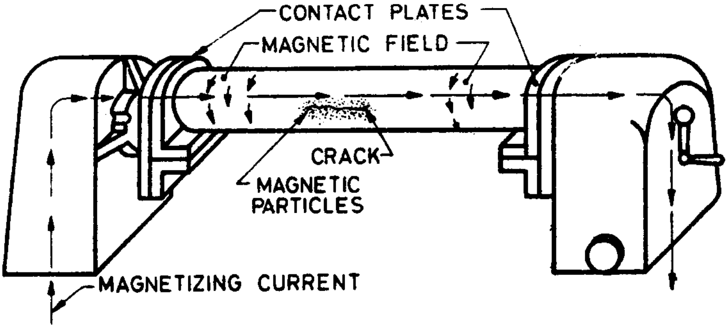

FIG. 2 CIRCULAR MAGNETIZATION OF TEST PIECE BY PASSING ELECTRICAL CURRENT THROUGH THE TEST PIECE FROM MACHINE CONTACT PLATES

A-2.1.2 *Circular Magnetization (Indirect Method)*—Circular magnetization may be induced in hollow parts by passing current through a conductor or conductors threaded or wrapped through them (Fig. 3) The conductor may either be a copper bar or cables. The current requirements are the same as that for the direct method, except that sometimes it is possible to increase the number of turns thereby reducing the amperage in direct proportion to the number of turns. In such cases the magnetizing force is expressed in ampere-turns. This method will produce *best indication of discontinuities essentially parallel to current flow*, including those on the inside diameter.

A-2.1.3 *Longitudinal Magnetization*—This is accomplished by the use of a coil or solenoid. Defects lying at right angles to the axis of the coil are detected. Smaller parts are placed within a coil or solenoid, but with larger parts, it is usually more convenient to magnetize by wrapping flexible cables around the part (Fig. 4). The magnetizing force is specified by the size of the coil and the ampere turns used. In general about 100-400 ampere turns per 25 mm of coil diameter are used. When inspecting long parts, magnetization and inspection shall be carried out at locations every 600 to 900 mm, along the length of the part. For detection of surface cracks, local areas can be magnetized by the use of yokes.

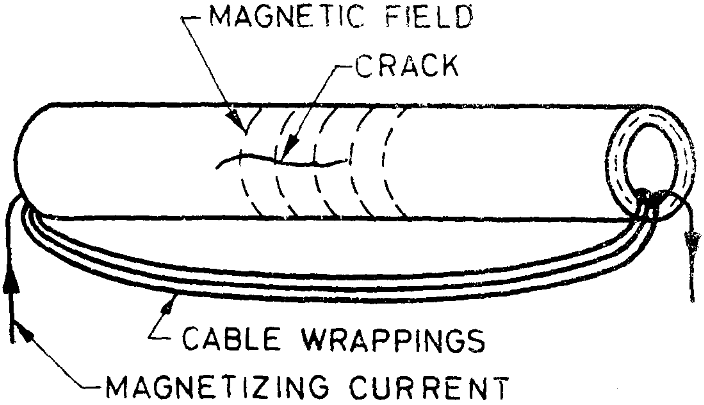

FIG. 3 CIRCULAR MAGNETIZATION BY PASSING CURRENT THROUGH CONDUCTOR WRAPPED THROUGH TEST PIECE

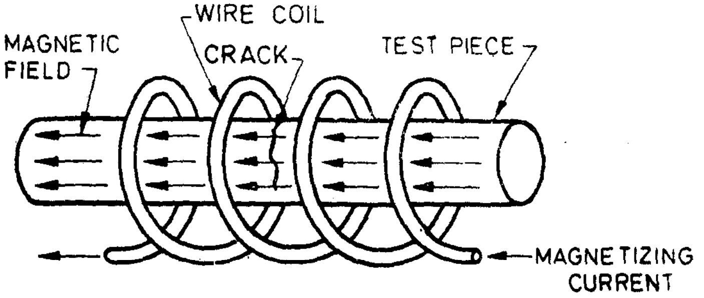

FIG. 4 LONGITUDINAL MAGNETIZATION OF TEST PIECE WITH COIL

A-3. MAGNETIZING CURRENT

A-3.1 Alternating current may be used instead of direct current where specified. It may be used for longitudinal circular or prod magnetization. Alternating current shall be used when the defects extending to the outside surface of the part are required to be detected, such as in the preventiv maintenance inspection to detect service or fatigue cracks.

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